Questacon

WHAT ? NEXT

Activities and Resources

Foldable Flight

Welcome to Questacon's webinar, Foldable Flight. In this session, students will investigate the engineering and physics of flight by constructing their own paper planes. This document provides information to prepare you and your students for the session.

Included in this document is an outline for the session, materials list, safety considerations, and ideas for extension activities to help maximise your students' learning.

What to Expect

In this webinar students will investigate two different types of paper planes: darts and gliders. Students will explore how various design features such as wing size, shape and angle can affect stability and drag. Students will be encouraged to experiment with different elements of their paper plane to make it fly just the way they want.

On the day

- Make sure you have materials on hand. The presenter will give verbal cues as to which activities will be coming up next and go through the activity instructions with the students.
- Your role during the session will be to help students through activities and facilitate discussions.
- You'll need a 'runway' or area to test student planes. This can be the classroom or a larger space nearby. Be aware planes often fly higher than expected and can get stuck in vents/trees or on roofs.
- Stay by the keyboard as you'll be your classrooms voice when it comes to answering polls or posting observations and questions in the Q and A.

Materials

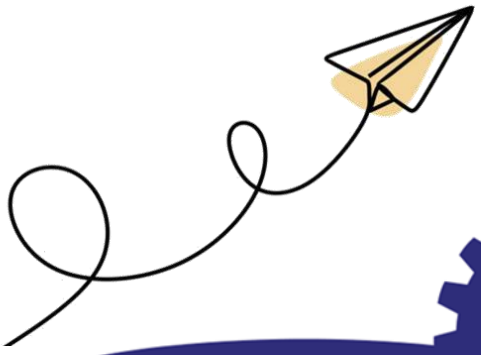
Each student will require:

- 2 x A4 paper
- 1 x Scissors (can be shared across students)
- 1 x Pencil/Pen (can be shared)

Safety

As students will be throwing paper planes, it is suggested that the following measures are recommended to avoid injury by a flying plane:

- We will instruct all students fold the nose of their plane in to avoid any pointy ends
- Students will need to ensure the space they are testing their planes in is clear of obstacles and people/animals in order to observe how their plane flies.
- We suggest students line up at one end of your space, throw together and then collect to ensure no one is hit.



Activities and Resources

Foldable Flight – Run Sheet

Runtime: 60 minutes

Please note these times are approximations, and programming on the day may change to give participants the most impactful and enjoyable experience possible.

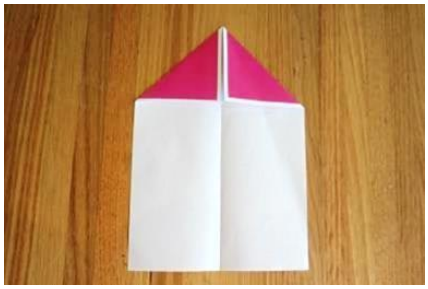
Time	Segment Description	Notes
5 min BEFORE	Audio visual check	Session will open for classroom to join. This is a good opportunity to ensure your whole class can see and hear the webinar, you can test the audio and adjust your speakers in Zoom.
0-10 min	Introduction to session Introduction to planes	The presenter will quickly run through the features of the webinar and how they will be interacting throughout the session. We will be asking students to nominate what parts of the plane they have heard of and discuss their various functions. We will also discuss the forces at work in flight.
10-15 min	Dart plane build	Presenter will walk through the steps of making the Dart plane slowly. Written instructions are included in this document.
15-20 min	Dart test flight	Students are to test fly their planes in a safe place and observe how they fly.
20-27 min	Test flight debrief	Students will be asked what their plane did whilst in flight. Presenter will go through observation and suggest reasons why flights may have differed from expectations. They will also go through some other plane features students may wish to test out on their dart planes.
27-35 min	Tinker time	Time for students to modify and test fly their planes.
35-38 min	Tinker time debrief	Students given opportunity to share what their plane did and how that changed between modifications.
38-45 min	Glider plane build	Presenter instructs students through folding the glider and how to “launch” it.
45-50 min	Glider test flight	Students test fly their glider.
50-60 min	Reflection and conclusion	Presenter will use student observations to compare and contrast the different paper plane styles, and summarise key concepts covered.

Activities and Resources

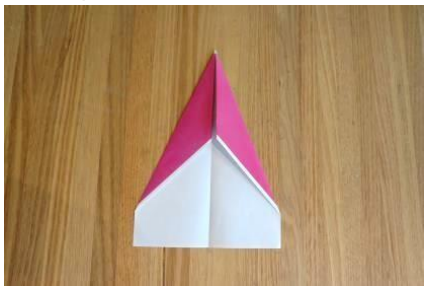
Foldable Flight – Dart Plane

1) Using one A4 sheet of paper, fold in half lengthways and open out again.

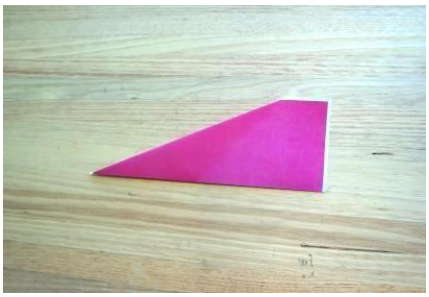
2) Fold the top corners of each half of the paper to the middle as shown.



3) Take the new corners that you just created and fold them in again to the centre, so it becomes pointier, like a dart.



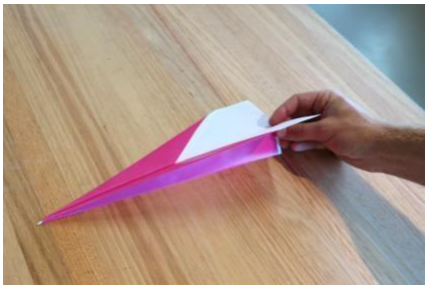
4) Fold the plane in half along the centre line.



5) To create your first wing, fold down one long edge to the centre line, in an angle similar to that shown in the picture below:

6) To fold the second wing down, flip your plane over and repeat on the other side, trying to get the fold exactly the same as the first one.

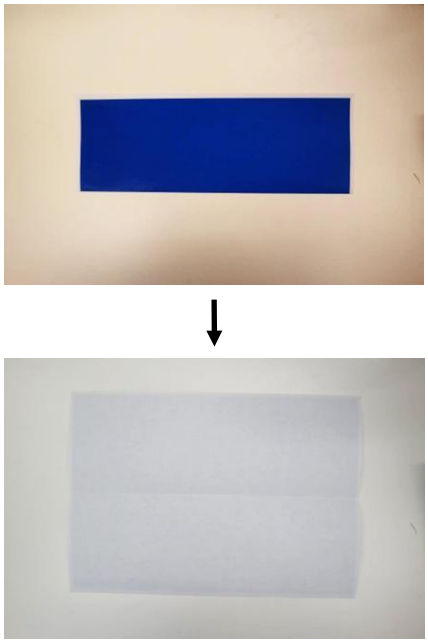
7) Once you have folded both wings you can adjust their angle so they aren't sitting too close to the body of the plane . Your dart plane should now look like this!



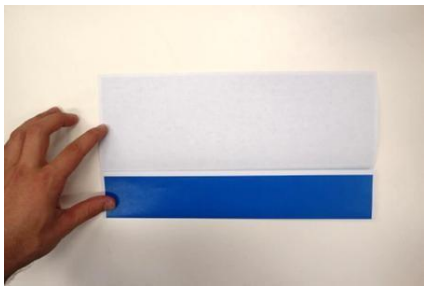
Activities and Resources

Foldable Flight – Glider

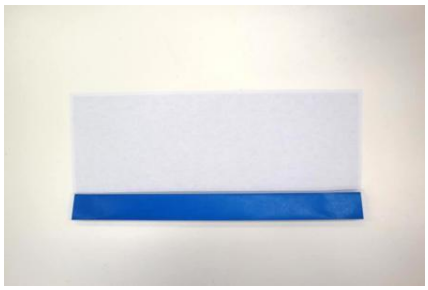
1) Using one A4 sheet of paper, fold in half lengthways and open out again.



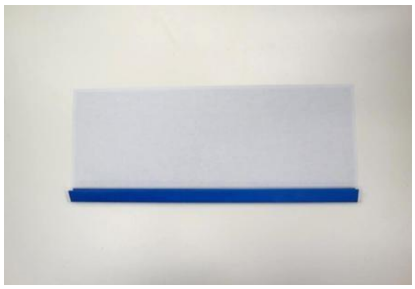
2) Fold the bottom edge up to the centre line.



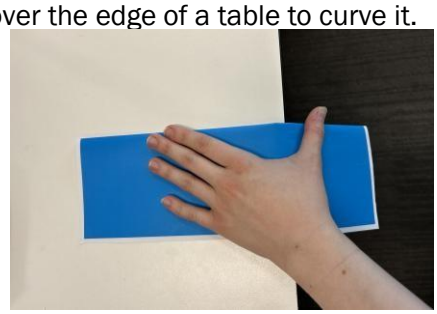
3) Take the new bottom edge and fold this up to the centre line as well.



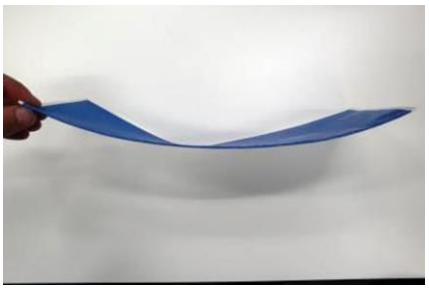
4) Fold the bottom half (the blue section) over the centre line onto the white section.



5) With the folded side down, pull the wing over the edge of a table to curve it.



6) Your Glider should now look like this!



Questacon

WHAT ? NEXT

Activities and Resources

Foldable Flight – Extension Activities

Listed below are some optional extension activities to further your students' learning. The activities utilise play and enquiry to explore physics and experiment with different design features. They can be completed independently and in any order.

Design competition

This activity is designed to prompt your students towards thinking about some of the design elements explored in the virtual excursion that will affect the paper plane flight. Using one A4 sheet of paper, the students need to design their own paper aeroplane. This can be a modified version of a plane that already exists (such as those that were discussed during the workshop) or a completely new design. You can then challenge your students to create a plane that flies in the straightest line, for the longest distance, stays in the air the longest, does the most loop de loops, turns left or right, the possibilities are endless!

Aerodynamics

Anything that wants to fly needs to create lift. As we discussed in the workshop, planes can create lift through the shape of their wings, but there are many factors which can also affect lift.

Start by looking at aerodynamics – if you drop two sheets of paper from the same height, at the same time, which one will hit the ground first? What if one of the pieces of paper is scrunched up into a ball? The difference between the two sheets of paper is not the weight, but the shape – the paper ball is more aerodynamic! Have students try and make something that will take the longest possible time to hit the ground using common household items, experimenting with different shapes, materials, and loads.

World record planes

People might think paper planes are just for fun, but the folks who compete in Paper Plane competitions are very serious! John Collins, the world record paper plane folder studied aerospace engineering and origami to make the perfect paper plane, and he has made his instructions available online. Though it looks simple, be warned it's a pretty technical plane! Challenge your students to have a go building the perfect plane: https://youtu.be/EDiC9iMcWTc

Build a cargo carrier

Paper planes - particularly darts, are models of planes but one big difference is the reduced weight in their fuselage. Challenge the students to reach the furthest distance with 'cargo'. Start by getting them to mark out a line 3.5 metres from their launch point and add 'cargo' to their plane until their plane can no longer make the distance. You can use whatever you have on hand as representative cargo. We've found coins work well, as the weight can be adjusted easily and good symmetry can be achieved between the sides of the plane. Students will require tape to secure the coins. Compete to see who can fly with the most cargo. In this challenge, encourage the students to think about the importance of weight distribution across the plane, and the impact this has on the flight path. Launch technique is also an important factor!

Activities and Resources

Foldable Flight – Extension Activities

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Winged seeds

There are other mechanisms for flight in nature apart from birds and bats. The Javanese cucumber has seeds which are built similar to our glider plane, allowing it to travel long distances before it reaches the ground. There are other plants that have seeds that spin like helicopter blades! You can collect these seeds or make models to compare how they interact with the forces of flight: gravity, lift, thrust, and drag. A template for one kind of seed spinner can be found here:

https://www.questacon.edu.au/learn-and-play/activities/seed-spinners

Centre of lift

The centre of lift (or centre of pressure) of a paper plane can generally be found as the middle point of its silhouette. The relationship between this and the plane's centre of gravity controls the inherent stability of a plane, whether paper or real.

This video simply defines the centre of pressure and how it compares to the centre of gravity:

https://www.youtube.com/watch?v=cyC0i_zOqkg

This video explains the stability profile of normal planes compared to fighter planes:

https://www.youtube.com/watch?v=VImEvFg3smQ

Centre of lift continued…

The stability profile of a plane is generally determined by where the centre of gravity is in relation to the centre of pressure. The centre of pressure is the average location of different pressure on an objects surface, where aerodynamic forces act. The centre of gravity in an aircraft acts as a fulcrum around which the plane pitches up or down. This can sometimes be moved forwards and backwards in a plane depending on where the luggage and fuel are stored and where people are located while the centre of lift remains the same. The stability in an aircraft is generally achieved if the centre of lift is behind the centre of gravity. You can see this in the way many commercial aircraft fly with a slight tilt - the tail is slightly lower than the nose.

This is the same for paper planes. It means that if the nose gets tilted up the increased lift this creates tilts the nose of the plane back down. If the lift was in front of the centre of gravity the increased lift would just keep tilting the nose of the plane up until it 'stalls'. This often occurs if you have got these two centres around the wrong way in a paper plane you have created yourself. To correct it, add more weight (more folds or Blutac) toward the front of the plane. This alters the weight distribution of the paper plane so that the centre of gravity is now in front of the centre of lift and can lead to a longer flight time.

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Activities and Resources

Foldable Flight – Curriculum Links

Listed below are links to curriculum to inform the connection between our interactive session and how they could apply to further learning in the classroom. These links are drawn from two areas of the Australian curriculum, 'Science' and 'Design and Technology'.

Science

Science Understanding

This virtual excursion links to the *physical sciences* sub-strand of science understanding. Students explore four forces that affect the movement of aeroplanes; thrust, gravity, lift and drag,

Year 4

Identify how forces can be exerted by one object on another and investigate the effect of frictional, gravitational and magnetic forces on the motion of objects (AC9S4U03)

Science as a human endeavour

This virtual excursion explores the practical applications of aeroplanes, and how different planes are suitable for different needs. Students also discuss the various design features of a commercial aeroplane and how these make it fit for purpose.

Year 3/4

Consider how people use scientific explanations to meet a need or solve a problem (AC9S4H02)

Year 5/6

Investigate how scientific knowledge is used by individuals and communities to identify problems, consider responses and make decisions (AC9S5H02)

Science Inquiry Skills

This virtual excursion's activities relate to science inquiry skills across all year levels. In the session, students will make and refine two different paper plane designs, and are encouraged to make predictions and observations, use safe and accurate testing techniques, and communicate their findings.

All year levels

- Evaluating
- Questioning and predicting
- Planning and conducting
- Communicating
- Processing and analysing data and information.

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Design and Technology

In this virtual excursion, students will explore the different functional features of aeroplanes, and how these affect movement of the plane. Students will also consider the movement of a model paper plane, and how we can alter the materials and techniques used to achieve a specific outcome.

Knowledge and understanding

Year 3/4

Investigate how forces and the properties of materials affect the behaviour of a product or system (ACTDEK011)

Process and production

Year 3/4

Explore needs or opportunities for designing, and test materials, components, tools, equipment and processes needed to create designed solutions (AC9TDE4P01)

Select and use materials, components, tools, equipment and techniques to safely make designed solutions (AC9TDE4P03)

Year 5/6

Investigate needs or opportunities for designing, and the materials, components, tools, equipment and processes needed to create designed solutions (AC9TDE6P01)

Select and use suitable materials, components, tools, equipment and techniques to safely make designed solutions (AC9TDE6P03)